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Polynesian Tapa Colourants

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If we consider the use of tapa pigments across Polynesian cultures as a set of historically related traditions, we find that certain key pigments were widely shared, and that there are also major groups of closely related pigments. Understanding the regional distributions and historical relationships of these can help us to interpret the cultural history of pigment in Polynesia. Colourant production throughout Polynesia is rooted in a broader cultural substrate of traditional ecological knowledge: the techniques and technology of materials processing, which historically informed foraging and horticulture, as well as the production of food and beverages, medicines and poisons. As in many other parts of the world, the prehistoric discovery of some pigments was most likely incidental to their more obvious use as foodstuffs. The discovery of others, conversely, demands that we understand ancient Polynesia's early settlers as conducting systematic experimental investigations into the properties of most (or all) of the plants available in the environment. For instance, the combination of processed materials in the production of some red or black pigments discussed below could only have been achieved within a cultural framework of experimentally exploring the reactive properties of every part of many species, and committing them to memory, alongside their interactions with one another.

Existing lists of named historical tapa types indicate that their colour (and colouring methods) were often intrinsic to their classification. The organisation of this discussion, however, primarily differentiates pigments into groups on the basis of the plant parts used, because this explains their regional history more clearly. We do not address the many pigments unique to Hawai'i in this discussion (see Schattenburg-Raymond, Chapter 6), focusing instead on those also produced elsewhere in Polynesia. Mineral and imported European pigments are also discussed briefly towards the end of the paper. In general, however, historical Polynesian pigment production was heavily plant-oriented. While the sources and extraction methods of many Polynesian pigments were fairly well documented in the 19th century, their finer details were often not. Thus, many pigments are described as 'brown', 'red' or 'yellow' without any details of their differences – or culturally-specific variations in classification – and several sources were often used concurrently in the same place to produce a given colour. Some processes of pigment extraction have not been performed for several decades; in certain cases, a century or more. As part of the

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research leading to this chapter, we therefore undertook experimental reconstructions on Mangaia (Cook Islands) in November 2017 to determine whether some of these details might be rediscovered. Mangaia retains good populations of several traditional pigment plants; it was one of the last islands of Central Polynesia to abandon tapa production in the early 20th century (see Hiroa, 1944). It has recently seen a renaissance in tapa making; and it has a healthy tradition of Māori medicine keeping local plant lore (as well as the people) thriving and well.

Brown and red pigments from tree sap

Brown, red or intermediate pigments derived from the tannin-rich sap of trees were very widely distributed across the whole of Polynesia. They were (and are) also the most popular pigments in Western Polynesia. Sap-pigmented cloth (in one form or another) was produced everywhere in Polynesia except the Marquesas Islands, Rapa Nui, and Aotearoa New Zealand (Kooijman, 1972). Across this vast area, sap was extracted from ten documented tree species, although four principal trees were exploited across large sections of that range.[1] In descending order of widest distribution, these four were *Aleurites moluccana* (*tuitui, tutui, kukui*, candlenut tree); *Bischofia javanica* (*koka*, *ʻoʻa*, *tea*, bishopwood); *Rhizophora mangle* (*togo*, *tongo*, one of the mangroves); and *Casuarina equisetifolia* (*toa*, *aito,* ironwood).

On one level, the large number of species used regionally can be understood as substitutions for one another necessitated by their shifting availability from place to place. On another level, however, these saps vary considerably in their hue, tone, gloss and viscosity – although all can be broadly described as 'brown' or 'red' in English. Sadly, their qualitative differences are not all known, as many of them were incompletely documented before use was discontinued. Where they are known, or experimental reconstructions can provide some insight, they are described here. In combination with knowledge of a pigment's distribution of use (see Table 5.1), and a cloth's origin, these details can often identify the pigments used on a fabric.

Only some of these saps are resinous; others are watery, syrupy, or latex-based. Some have been erroneously described in European sources as extracted from the bark of the tree, but all four of the main colourants listed above are primarily extracted from the outer sapwood (secondary xylem), with only a minority of liquid coming from the bast, and probably none at all from the cortex. The cortex is the dry, sapless outer bark of the tree, and resinous sap is generally produced and transported in the outer wood (Capon, 2010: 64-65). Sap extraction is a destructive process, and artistic practitioners from Samoa and Tonga (where *Bischofia javanica* resin is still regularly extracted for pigment) emphasise that trees must be carefully managed to avoid killing them and maintain the resource for future use. The primary function of bast is the transmission of sugars around the tree from the leaves, and therefore ring-barking the entire circumference at any point will kill almost all trees. Therefore, sap is best extracted from only one side of the tree,

1 The other documented Polynesian species providing sap-based pigments include a red paint in Samoa extracted from the *pani* tree (*Metrosideros collina*, a relative of the New Zealand *pohutakawa*); on Rotuma, a brown resinous pigment from the *ifi* (*Inocarpus fagifer*, the Polynesian chestnut); a weak brown from the *piri piri* of Tahiti (probably *Urena lobata*, although several unrelated species are classed as one form or another of *piri piri*); as well as two Hawaiian species, a yellow from *holei* (*Ochrosia compta*) and a pinkish red from *kōlea* (*Myrsine lessertiana*).

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Locality	*Rhizophora mangle*	*Bischofia javanica*	*Aleurites moluccana*	*Casuarina equisetifolia*
Fiji	✓	✓	✓	
Tonga	✓	✓	✓	
Samoa	✓	✓	✓	
ʻUvea	✓	✓	✓	
Niue		✓	✓	
Futuna		✓	✓	
Cook Islands		✓	✓	✓
Society Islands			✓	✓
Austral Islands			✓	✓
Mangareva			✓	
Hawaiʻi			✓	

Source: Kooijman (1972).

Table 5.1. Use of the four commonest resinous tree saps as reddish-brown colourants, by locality, circa 1850.

leaving the remaining bast to support the plant until the wound can heal. The extraction of *Bischofia javanica* in Western Polynesia is well documented, and as it is the dominant brown pigment used on Tongan *ngatu*, its colour can easily be observed in museum collections – and is at any rate still well known to be a matt, chocolate-to-earthy brown (see Veys, Chapter 11; Veys, 2017: 42). The colour of *Rhizophora mangle* sap is not described in historical sources better than a 'reddish-brown', although it is known to produce a glossy varnish similar to *Aleurites moluccana* described below (see Chapter 9, Figure 9.5).

On Mangaia in 2017 we extracted sap from both tuitui (*Aleurites moluccana*) and toa (*Casuarina equisetifolia*). This showed us that, despite there being a rich reddish-brown colour visible in their inner barks, no pigment can be extracted, while the outer wood is full of resinous sap of exactly the colours found on tapa. In both cases, a bush knife was used to shave off a large area of the trunk's outer bark around approximately 150° of its circumference. Once barked clean, the outer 5-10mm of sapwood was shaved off onto a tray as a coarse sawdust (Figure 5.1a). *Aleurites* shavings have a darkish burgundy-brown colour, while the *Casuarina* shavings are a surprisingly bright raspberry-red colour (Figure 5.1b). Only older trees seem to yield an appreciable quantity of sap, and older trees also give a darker sap. Approximately 1kg of shavings were collected from each species. Each set of shavings was moistened slightly and wrung out firmly using a coarse muslin to produce about 500ml of each liquid. In the Cook Islands, *Aleurites* extract was historically known as *vavaiʻiri* and *Casuarina* extract termed *toto* (blood) (Figure 5.1c). Both extracts continue to be used in Māori medicine today, and therefore we must understand their historical production as pigments to be merely one aspect of a more thoroughgoing system of organic resource production integral to the technological base of Polynesian civilisation.

Both extracts were slightly sticky and resinous, but the vavaiʻiri from tuitui significantly more so. Their colours mirror that of their shavings: the tuitui produces a burgundy-brown (Figure 5.1d), and the toto from *Casuarina* a bright raspberry-red, characteristically pinkish (Figure 5.1e). Vavaiʻiri had a marked stiffening and glazing effect on cloth immersed in it for as little as 30 seconds and remained slightly tacky until fully dry. In general, these resinous

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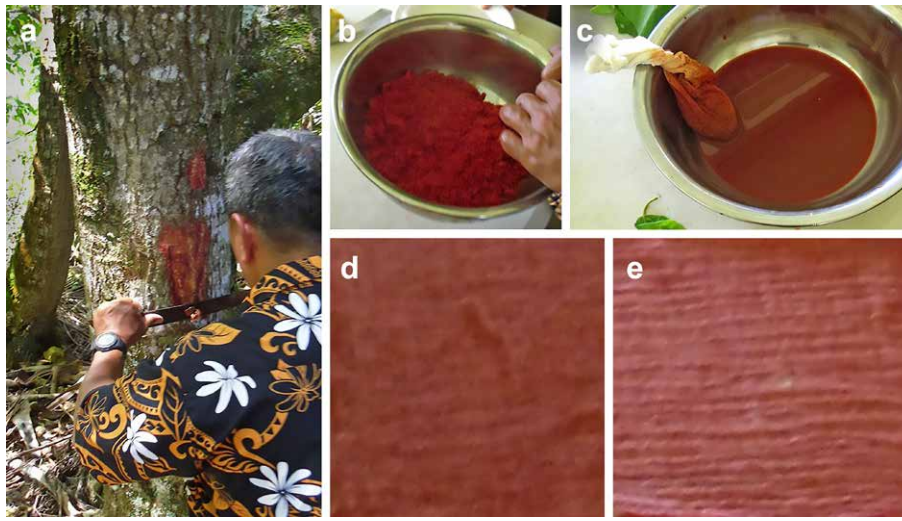

Figure 5.1. Production of tree sap colourants: a) Nooroa removes the bark from an *Aleurites moluccana* tree. b) The remarkably red shavings of *Casuarina equisetifolia* wood. c) Vavai'iri, the sticky, brownish-red extract of *Aleurites moluccana*. d) Dyed fabric sample of *Aleurites moluccana*. e) Dyed fabric sample of *Casuarina equisetifolia*.

pigments take longer to dry than the water-based ones discussed below. The *Casuarina* dye was also slightly stiffening but very matt. We also produced a traditional Mangaian mixture of the two (Hiroa, 1944: 72), which retains the glazed quality of the tuitui but also lifts the colour significantly towards a rich blood red, while losing the pinkish hue of the toa alone. Undoubtedly repeated immersions or applications after drying, or the production of a more concentrated dye, would have intensified the colours significantly.

In Tahiti, all such sap extracts (whether for pigment or otherwise) were classed as *hiri,* and in Hawai'i as *hili* (Ellis, 1832; Hiroa, 1957: 187); some were boiled with hot stones to improve extraction and the colour itself. Extract wringers (*fautaukoka*, *taka*, etc.) for deriving liquids from such masses of processed vegetable matter were historically manufactured in various ways across Polynesia, but this kind of ephemeral practical tool is rarely found in museum collections; typically, they were woven from *Pandanus* leaf or *Hibiscus tiliaceus* bast strips, although the sieve-like coconut spathe has long been preferred on Mangaia. An important wider point about these resinous sap extracts – and that of the candlenut in particular – is that they provide the base for many other red and black pigments throughout the region, and often had various colouring agents added to them subsequently. On this point, the black pigments are discussed next, and the ochres later, but before leaving the brown sap pigments, it is worth noting that they were traditionally darkened by adding charred *tou* wood (*Cordia aspera*) in Samoa, and more recently by boiling with old nails in Tonga (Kooijman, 1972: 217; Veys, 2017: 42); therefore, both the redness and the darkness of brown pigments have been open to significant manipulation by paint makers for centuries. Several of these sap-derived pigments imparted a degree of water resistance to tapa immersed in, or painted with, them.

The bark or outer wood of three trees of the genus *Syzygium* (formerly *Eugenia*) provided pigment in both Western Polynesia and Hawai'i. The canoe plant *Syzygium*

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Figure 5.2. Candlenuts, the fruit of *Aleurites moluccana*. When burnt, soot from these oily kernels is the principal source of almost all Polynesian black pigments.

malaccense (the Otaheite or Malay apple; Plant Profile 16) provided a dye described as red in Samoa and Niue (where the plant is *nonu fiʻafiʻa* and *kafika* respectively), but brown in Hawaiʻi (where it is called *ohiʻaʻai*). This discrepancy may be explained by the greater availability of more brilliant reds in Hawaiʻi, which Western Polynesia lacked prior to the importation of *annatto* discussed later. Given the fruit's popularity for food throughout the region, it is a little surprising that the pigment should not be known elsewhere, but it may have been entirely superseded by the *mati* pigments discussed below, then forgotten. Similarly, the bark of two related endemic species of Southern Lau in Fiji, *yasi-ni-wai* (*Syzygium seemannii*) and *yasiyasi* (*Syzygium effusum*) provide one of the red extracts added to *Aleurites* sap in the production of *kesa* pigment (Kooijman, 1972: 358).

Soot-based black pigments

Black was probably the most important of all Polynesian pigments, and it seems clear that a stable, rich true black had been perfected by the time of Polynesia's first settlement. Everywhere across the region, the source of the best black remained the same, and was the same as the black pigment used in Polynesian tattooing: the fine soot or lampblack given off during the burning of candlenuts, the oily kernels of the fruit of the *Aleurites moluccana* (tuitui, tutui, kukui, *lauci, lama, tiara*) (Figure 5.2; Plant Profile 10). Traditionally bored through and strung on the pinnule of a coconut leaflet to form 'candles' for lighting the home, in windless conditions an extremely fine oily soot can be collected from these kernels by inverting a coconut shell over them as they burn. This is then mixed into one of the brown sap pigment bases outlined above to produce a stable, true glossy black. From

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the great predominance of candlenut sap also being the preferred base, and the tree being a canoe plant brought by the settlers, it seems likely that this practice was brought into Polynesia with the tree as an established bi-production practice of domestic lighting. While the double-source (kernels and sap) *Aleurites* black was found from Fiji to Hawai'i, there were important variations worth discussing here, and other quite different black pigments produced in certain places.[2] While candlenut soot was relied upon in some areas of Fiji, in others *makadre* resin (also used to varnish ceramics) harvested from the *dakua* tree (*Agathis vitiensis*, now known as *A. macrophylla*, the Fiji *kauri*), was burnt and its soot gathered, in an identical manner to the candlenut method (Kooijman, 1972: 355-356). This makadre-based black (termed *loaloa*) is perhaps the deepest and most even found in the region, and its *Aleurites* base makes it notably more matt. In Tonga, Samoa, Futuna and 'Uvea, however, the preferred brown sap of the *Bischofia javanica* was also the principal base for black pigments, producing the glossy black of Tongan *ngatu 'uli* and Samoan *siapo ema*.

Anaerobic earth-based black pigments

Perhaps the simplest and most ancient blackening method for tapa was its immersion in iron tannate/hydrogen sulphide-producing black mud generated by anaerobic bacteria in silted-up lagoons and estuaries, coconut plantations or wet taro paddies (Sumich and Morrissey, 2004: 206). The latter was the commonest method for producing the popular black tapa called *pakoko* on Mangaia (Hiroa, 1944: 72). This same technique was used throughout Polynesia to dye coconut husk fibres black, and was equally carried to Aotearoa New Zealand, where Māori used it to dye the leaf strips and fibres of *harakeke* (*Phormium tenax*) (Smith et al., 2018). While one might superficially expect these anaerobic silt dyes to have had a purely *aesthetic* purpose, this treatment was also widely understood to have both antifungal and insecticidal effects on the material steeped. Indeed, in the context of tapa, this may explain (in part) the origin of black fabric's use for shrouds and mourning dress.

In certain areas, a combined series of the foregoing techniques was deployed to redouble their effects. Thus Hiroa (1944: 72) describes a four-stage method employed on Aitutaki where cloth was immersed first in the vavai'iri liquid from *Aleurites* and dried; then in the toto liquid from *Casuarina* and dried again; then steamed in an earth oven lined with banana stem slivers and *Aleurites* leaves (although it is presently unclear what this phase did to the cloth); and finally it was soaked in a taro paddy until it reached the desired shade of black. An analogous complex multi-phase black dyeing process was also documented by Hiroa (1957: 189) for the production of *kaha* fabric in Hawai'i. Unbeaten bast strips were first soaked in *Aleurites* pigment (hili kukui), then beaten and fused into a fabric before a second immersion in kukui dye; then the cloth was immersed in the taro patch for several days, before it was transferred to a calabash stuffed with the ferns of the *pala'a* (*Davallia tenuifolia*, now known as *Odontosoria chinensis* subsp. *tenuifolia*) a red dye in its own right) to stand for several more days. Thereafter it was removed and rinsed thoroughly to clean off the mud and grit, scraped down with a bivalve shell (leaving distinctive wavy-edged broad parallel grooves on the fabric), soaked a final time and finished carefully with the beater. These two separate occurrences of an evidently related process should alert us to the probability that this was a more widespread dyeing complex

2 Kooijman (1972) reports that *Aleurites* also produced a third pigment of a coppery colour in Hawai'i, from its pounded roots and chewed raw kernels.

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of Eastern Polynesia, dating back a thousand years or more in some form. Equally, Hiroa's comment (ibid.) that two other Hawaiian fabric types – *hulili* and *pele* – were produced by closely related methods, shows that this had become a generalised system of dyeing practice in Hawai'i, rather than a unique method.

Rhizome and root extracts for yellow and other colours

Another major technological pigment group of Polynesia is that based on grating or pulverising, and then straining or wringing out, rhizomes and roots. There is some basic mechanical affinity with the extraction of saps described above, but these rhizome and root infusions had water added to the comparatively dry pulverised matter (or were watery enough in themselves) to produce a cold infusion that was then strained, wrung out or drained to a useful consistency. In truth, there are much closer analogies with the processes and tools for preparing the definitive Oceanic beverage *kava* (*Piper methysticum*); it also served as a pigment and is discussed below. Such water-based pigments were generally used as immersion dyes, and only occasionally painted on with brushes, or applied with stamps. The two principal Polynesian yellows were produced by this method: turmeric (*enga*, *lega*, *ango*, *cago*, *renga*, *rea*, *ena*, *olena*, *Curcuma longa*) and *Morinda citrifolia* (*nonu*, *nono*, *noni*). Turmeric was the most widely used of all Polynesian tapa pigments, and can be found in the historical literature, and on tapa in museum collections, from every part of the region except Tonga and Aotearoa New Zealand (Plant Profile 11).[3] In essence, the basic process of extraction is simple: we dug up about a handful of garden turmeric rhizomes, approximately 1-2cm in diameter, which we washed and dried (Figure 5.3a). Polynesian turmeric varieties seem considerably more orange than the yellower South Asian turmeric sold on the global spice market. Once grated, no water was added as the fresh rhizome is wet enough. Wringing it out through muslin produced around 200ml of a rich, opaque orange-yellow dyeing liquid (Figure 5.3b). When white cloth was immersed in the liquid, the colour taken was very consistent with it.

Historically, the processing of turmeric was more refined and varied subtly from place to place. In general, the rhizomes were peeled, grated, soaked in water, and the solid fibrous component either strained or picked out. Once this was done, the bright orange-yellow suspension was left for several days to settle out, and the clear water poured off. The residue was dried completely to a fine-grained cake which was ground into a dry powder (Hiroa, 1944: 71-72). An important variation on this basic method was found in Samoa, Futuna, Rotuma and the Marquesas Islands, where the turmeric suspension was poured into a coconut shell and then boiled or roasted in the embers of a fire to reduce it down to a dry powder. Handy's (1923: 292) data from the Marquesas shows that this roasting could darken the pigment towards a deeper orange (*eka moa*), and the distinctive fabric dyed with it was an exclusive prerogative of both male members of the *ka'ioi* society and female chiefs (Kooijman, 1972: 182-183). Similarly, in Futuna, where turmeric pigment production had itself attained the status of a professional craft specialisation, two distinct yellows were

3 The absence of turmeric-painted tapa from the historical Tongan corpus is more apparent than actual: the *vaka 'otua* (deity manifestation vehicles) of pre-Christian Tonga were primarily *kato'alu* baskets containing reliquary bundles of woven fibre garments, whale's teeth and so on, wrapped into a bundle of turmeric-coated tapa (Gifford, 1929). We have no idea whether this *ngatu 'enge'enga* was *kupesi*-rubbed or simply painted, but doubtless every scrap of it was destroyed by the late 1840s or shortly thereafter; logically, it would have been tapu beyond comparison even with ngatu 'uli.

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derived at the sifting stage: the finer particles were separated to generate a brilliant orange pigment (*ama*) reserved entirely for body paint, while the coarser particles provided a duller orange pigment (*taua*) for dyeing cloth (Burrows, 1936: 189-199; see Guiot, Chapter 12).

These points above reflect a key point about turmeric pigment which has regional relevance: everywhere in tropical Polynesia, and the Polynesian Outlier societies further west, it was first and foremost a body paint rather than a fabric dye, and a ritually important, supernaturally efficacious substance. Indeed, its near-universal use as a fabric pigment can only be understood culturally in light of that fact – and this is almost certainly the principal reason why yellow is so prominent in historical Polynesian art as a whole: the name of the plant and the colour classification are basically indistinguishable in Polynesian languages. In preparing it for application, the dry renga was made up with coconut oil; on Mangaia (and perhaps elsewhere) a coconut cream base provided a paler, more matt pigment which defined the *paʻoa-tea* fabric type. For both turmeric and the other rhizomes and roots discussed here, Hiroa (1944: 72) also mentions Cook Islands Māori women adding a little seawater – seemingly concrete evidence that Polynesian dyers were just as aware of the efficacy of salt fixatives on vegetable fibres as their European contemporaries (Fairlie, 1965: 492-493). Cultural historians are still reconstructing the ritual function of turmeric in the pre-Christian cosmologies of Polynesia, but the consensus seems to be that it possessed the capacity to render people and things *tapu* (supernaturally demarcated, sacred to the gods) and enlivened. While turmeric dye self-evidently imparted profound aesthetic qualities to cloth, therefore, we simply cannot disentangle those aesthetic qualities from its sanctity and symbolic value – they were one and the same.

Although less culturally significant than turmeric, *Morinda citrifolia* (nonu, nono, noni) was a key secondary yellow pigment of Polynesia, used in Samoa, ʻUvea, the Society Islands, Austral Islands, Cook Islands and Hawaiʻi (Kooijman, 1972; Plant Profile 12). In general, the extraction process is fairly well understood and was undertaken on Mangaia in 2017. We uprooted a self-seeded nono sapling which was growing in an inconvenient location, digging carefully to preserve the brittle side roots as well as the tap root. From a tree 2.5m tall, we lifted a tap root 7-8cm in diameter at ground level and 50cm long (Figure 5.3c). We washed it and left to dry overnight, then the next morning we peeled off the root's thin, copper-coloured bark. Nono has a bright orange, moist and pulpy root cortex approximately 5-10mm thick, surrounding its woodier yellow root stele (Figure 5.3d). Shaving with the bush knife once again produced about 500g of orange root cortex pulp, which needed no additional water before wringing out, and gave a surprisingly bright, clear yellow watery liquid. When white cloth was immersed in this liquid, it dyed a bright and clear shining yellow (Figure 5.3e). In those cloths from parts of the Cook Islands (*e.g.* Aitutaki) and elsewhere upon which both orange and yellow pigments are found in combination, it is consequently useful to know that *Morinda* (on its own) can only provide a true cool yellow colour – *i.e.* similar to ripe bananas or lemons – while turmeric always has some warm orange tone to it. In the Society Islands, Austral Islands, Hawaiʻi and possibly elsewhere, this bright yellow colourant was chemically transformed into a blood red one through its halochromic sensitivity to alkaline ground coral (Flowers, Smith and

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Figure 5.3. Production of yellow colourants in Polynesia: a) Selected and washed rhizomes of Polynesian turmeric, *Curcuma longa*. b) Grated and wrung out, turmeric extract is of a markedly orange-yellow hue. c) Nooroa demonstrates the bright yellow root cortex underlying the root bark of nono, *Morinda citrifolia*. d) Its bark removed, the stark difference between the soft, moist outer nono root cortex and the woody, dry root stele can clearly be seen. e) Dyed fabric sample of *Morinda citrifolia*.

Brunton, 2019).[4] Contrary to some sources, no pigment (yellow or red) can be derived from the aerial bark or bast of *Morinda citrifolia*. The outer bark of both roots and aerial stems is thin, dry and papery, while the aerial bast is thin and mucilaginous, a chlorophyll-tinged mustard colour, and bleeds out only small quantities of a thin, watery and colourless sap. We infer that Aitken's (1930: 82-83) hypothesis, that the source of red nono pigment could be found in another part of the same plant, was merely a hypothesis and nothing more, made in lieu of an awareness of its pH sensitivity.

Kooijman (1972) catalogued four other dyes produced in substantially the same manner across the region. The rhizomes of the fish poison *kavapiu* provided a paler yellow dye than nono in the Cook Islands. Some Tahitian women used the true kava root (*ava, Piper methysticum*) to dye tapa its distinctive beige-grey colour. In Rotuma, the root cortex of the *pakou* (a sedge, *Kyllinga nemoralis*, now known as *Cyperus mindorensis*) provided a brownish-purple pigment that was mixed with turmeric as a substitute for the sap-based browns enumerated above. In Fiji, the root cortex of *gadoa* (*Elaeocarpus storckii*) produced a brownish-red that was boiled with soot and red ochre to give a dark brown.

4 According to Buck (1930), two varieties of *Morinda citrifolia* were recognised in Samoa; the *nonu vao* (bush *nonu*) and the *nonu 'ulu* (clump *nonu*); they had been abandoned for pigment production by the time of his ethnographic work in the early 20th century, and therefore, whether there was any difference in their tone is now unclear. Martin (1817) similarly discussed its use in Tonga for dyeing weaving materials but makes no reference to its application to tapa.

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The mati dye complex

The family of bright red dyes called mati (after the fruit of the *Ficus tinctoria*, their one common ingredient) were produced, to one recipe or another, in the Society Islands, Austral Islands, Cook Islands and Hawai'i. Placed within the context of the now well-established chronology of Polynesia's human discovery and settlement, this distribution allows us to infer with some reliability that the discovery of its production process probably occurred in the Society Islands during its earliest prehistoric phase of human occupation (ca. 600-1100 AD). In mati production, a chemical reaction occurs between the latex of the *Ficus tinctoria* fruit and the crushed leaves of the partner plant – most often those of the tou or *kou* tree (*Cordia subcordata*) in the process first described in 1769 (Parkinson, 1773; Banks, 1962). In total, five different species were harvested to provide leaves for the mati dye process. As well as tou leaves recorded across the full range of mati's production, in both the Society Islands and Cook Islands mati latex was also reacted with the leaves of the *bua* or *morirei* (*Solanum repandum*, the native Polynesian tomato), and in the Societies alone, also the *taheino* (*Messerschmidia argentea*, now known as *Heliotropium arboreum*) and the *pohua* (*Ipomoea pes-caprae*). This range of plant constituents shows that mati was not a single red pigment, but rather a technological complex of closely related pigments produced by a single methodology. We do not presently know what variation in pigment properties resulted from the use of these different leaf species.

As HMS *Endeavour* was sailing back to Europe, Banks (1962) wrote with dismay that some of the mati-dyed cloths he had purchased and been gifted in the Society Islands were already fading heavily within a matter of months.[5] The resultant pale candy pink colour, which is still a very beautiful hue, is believed to be present on some early Society Islands cloths in museum collections, including the Tahitian *ahu* samples used by Alexander Shaw (1787) in his albums of barkcloth from the Cook voyages. The ephemerality of some mati is of considerable interest to us now, as many historic tapa are as richly coloured today as they were some 250 years ago. The most logical hypothesis to explain this variable fading of mati is that different leaf species produced different degrees of permanence in the pigment, though this has not been tested. The concurrent production of mati in both the Society Islands and Cook Islands using more than one leaf species suggests that different pigment properties resulted from each. Subtle variations in the pigment colour are the most likely motivation for the use of such a large range of plants, although those colour variations are presently unknown. Equally fastness of the colour, and local availability of the relevant leaves, may have been important factors.

5 When Sydney Parkinson and Sir Joseph Banks first documented mati production and use on Tahiti in 1769, both were entranced by its brilliant scarlet colour, which Banks observed was a truer, richer red than any pigment available in contemporary Europe. Banks was particularly fascinated by mati's production process as evidence of a complex chemical industry and scientific experimentation in 18th-century Polynesia, although it is unlikely that he grasped the long centuries of Austronesians developing a profound traditional ecological knowledge of Malesia, upon which the pigment's discovery was built. However, the significance of the pigment for Banks' philosophical musings on the technological capacities of the Polynesians centred on the fact that neither of mati's components is itself red prior to processing, and therefore its discovery evidences a history of strategic experimentation; Banks' intention was substantially to prove that precisely those same faculties of rational scientific enquiry that were industrialising Europe at the time, were equally evident in the geographically and culturally distant South Sea Islands.

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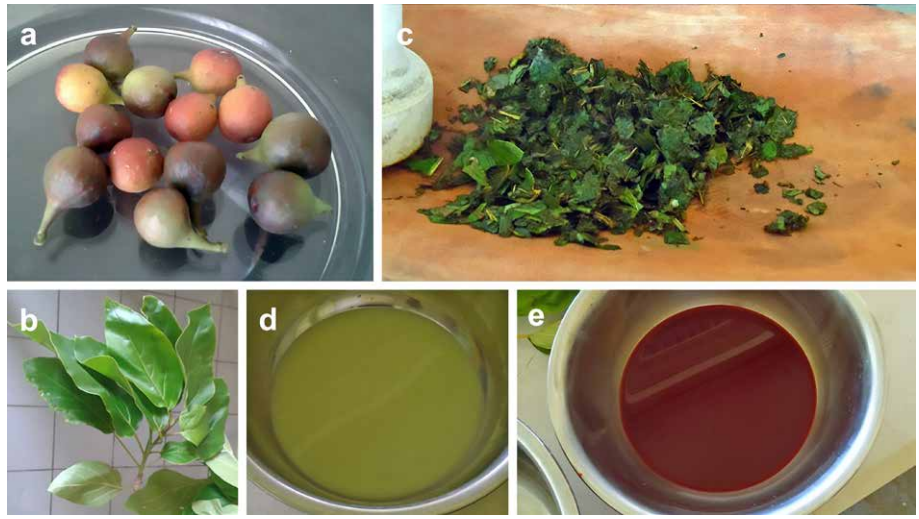

Figure 5.4. Components and stages of mati dye production: a) The figs of the mati tree, *Ficus tinctoria*. b) The leaves of the tou tree, *Cordia subcordata*. c) Shredded and pounded, the tou leaves begin to oxidise, darken and redden. d) Vai mati (mati water), the latex-rich, sticky product of immersing the figs. e) Mati dye itself, following ten minutes' immersion of the pounded tou leaves.

We produced mati on Mangaia in November 2017. Even on Rarotonga, *Ficus tinctoria* is now extremely rare. A large mati tree grows in the grounds of the government buildings in Oneroa, however, and was in heavy fruit, so we picked around 200 (Figure 5.4a). The stalk ends were pinched off the figs, which exude a yellow-white milky latex. The figs were dropped into a bowl of fresh water, and after processing around a hundred fruit like this, the water became cloudy and grey, and then an opaque yellowish-white, in 10-15 minutes. This is the *vai mati* (mati water) described in historical accounts (Figure 5.4d). We collected tou (*Cordia subcordata*; Plant Profile 14) leaves near Oneroa harbour (Figure 5.4b). They were prepared by tearing them into 1-2cm shreds, then pounding them for 5-10 minutes – during which time the bruised shreds became dark green and began to take on a dark reddish tinge at the edges and in the veins, seemingly by oxidation alone, or the mixing of previously separate chemicals within the tou leaves themselves (Figure 5.4c). When we wrapped the pounded tou in a muslin bag and immersed it in the vai mati, filaments of brownish-red pigment immediately began to diffuse into the water, which darkened. After five minutes, the liquid was a strong, solid and fairly dark scarlet, and a dipped fabric sample took on a bright and extremely beautiful clear orange-pink tone. After five more minutes of immersing the tou, the vai mati had become a dark blood red (Figure 5.4e). Subsequent discussions among ourselves highlighted the number of potential varying factors in this complex process: notably, the number and ripeness of the mati fruit (green figs seem to produce more latex); the number and size of the tou leaves (young leaves are more succulent); the vai mati infusion time; and the tou immersion time. Clearly, much further work, and further analysis of the cloths, remains for the lost details of this iconic Polynesian pigment's production to be rediscovered.

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Other colourants from aerial plant parts

Given the complexity of the pigment groups discussed above, it should come as no surprise to the reader that a range of other Polynesian colours were derived from the fruit, flowers, leaves and other succulent parts of various plants. Three notable fruits were used in Polynesia for pigment production. The *hea* (*Parinari insularum*) is a tree endemic to Fiji that was carried to Tonga and ʻUvea in ancient times, seemingly for different reasons: in Tonga, its ripe red drupe provided a brilliant red glaze that was very popular around 1800 (Martin, 1817). In ʻUvea, however, the unripe fruit was pressed for its oily juice which provided a perfumed base for both turmeric and *Morinda* yellows (Burrows, 1938: 132). In the Society Islands and the Cook Islands, *tamanu* (*Calophyllum inophyllum*) nuts were cracked for the veins of rich sulphur-yellow pigment running through their cream-coloured kernels. On Mangaia in 2017, we extracted a pale yellow dye from tamanu nuts in this way; grating them finely to a pulp, adding a little water and wringing them out to produce an opaque, oily yellowish cream-coloured dye. A cloth immersed in it took on a pleasant, delicate primrose-yellow colour. In the Society Islands, the edible purple fruit pulp of the *motuʻu* tree (*Melastoma affine*, now known as *M. malabathricum* subsp. *malabathricum*) also provided a bluish-purple pigment; although no details of its historical processing are recorded, the tree's common name in English is 'blue-tongue', so it was no doubt merely the juice.

The stems of two banana varieties were tapped for their colourful sap: in Samoa, the *soaʻa* (the mountain plantain, a *Musa* hybrid of unclear ancestry) produces a dark violet pigment at the base of its pseudostem (Buck, 1930: 302-304). In the Society and Cook Islands, the *feʻi* banana (*Musa troglodytarum,* a short-fruited and thickly seeded species) similarly provided a pigment described by Wilson (1799: 190) as black; this was harvested from a banana side-sprout on Rarotonga in November 2017 and is also an extremely deep inky violet. Another stem part furnishing a yellow pigment in the Society Islands was the leaf petioles of the popular carving tree *miro* (*Thespesia populnea,* the Pacific rosewood).

Beyond the mati complex outlined above, very few leaves are listed as providing pigments in Polynesia. On Mangaia, the *ʻange* (*Geniostoma sykesii*) is one exception; its pounded leaves were infused into coconut cream to provide a perfumed oily grey pigment (Whistler, 1990). There are similarly few flowers described as providing dyes, but the foremost is undoubtedly *Hibiscus rosa-sinensis* (*kaute*). On Mangaia in 2017, we struggled to find the Polynesian-introduced *Hibiscus* (one of the few ornamental canoe plants) although numerous imported ornamental hibiscus varieties from Asia are growing all over the island. We eventually found a pair by the roadside and harvested about a dozen flowers. Although light scarlet when they open, the flowers become purplish as they fade, and we found that pounding them whole (as the sources describe) produces the same darkening colour change. Wringing this mass out produces a mucilaginous and unpromising goo which, when we immersed cloth in it, took a long time to dry, but gave a useful violet-blue colour, though with a patchy stained appearance. Tuara remembers Mangaian children staining their lips and cheeks with the prominent colourful anthers of the hibiscus flower in play a few generations ago, and we hypothesised that these parts may not contain the disruptive mucilaginous components of the petals. We collected anthers from more flowers, pounded and pressed these in a little water to obtain a clear, bright amethyst-purple dye which coloured cloth a light lilac. Given the foregoing points,

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it seems unlikely that Hiroa's (1944: 72) description of *Hibiscus* flowers being pounded then rubbed onto tapa to create splashes of red is accurate; the result must have been a purple of some kind. He mentions that this dyeing process was performed at sunset, and the tapa dried overnight, to prevent fading, so we might expect that this was a particularly ephemeral pigment and may be little in evidence on historical cloths today.

Ochres and European-introduced pigment plants

As well as being locally available on ʻUvea and Futuna, the sources of good red ochre within Western Polynesia are enumerated clearly by Kooijman (1972), and are still well known today: in Fiji, Komo island in Lau, Bau island, and the northern coast of Macuata; ʻEua island in southern Tonga and inland from Neiafu on Vavaʻu in the north; upland areas of ʻUpolu and Tutuila in Samoa. Ochre use (which was surely there anciently) seems to have disappeared throughout the Society Islands, Cook Islands, Austral Islands and Marquesas Islands by the late 18th century. This suggests that it was entirely superseded by the discovery of the scarlet-producing mati, and lime-reddened *Morinda*, discussed above. The use of both red and yellow ochres in Hawaiʻi, and red and black ochres on Rapa Nui, is equally well documented; no doubt motivated by the seemingly ceaseless pursuit of manifold colours in the former case, and by lower biodiversity in the latter. Everywhere it was used, ochre was ground and suspended in oil to make a stable pigment. Often the evidence of this oil base can be seen on the reverse of Hawaiian kapa where it has soaked through and darkened the cloth.

There is one good reason to discuss the use of ochreous pigments (*ʻumea*, *ʻele*) and introduced European plant pigments in the same place: throughout Western Polynesia, the former were heavily replaced by the use of *Bixa orellana* (*loa*, kesa, annatto) in the late 19th century. *Bixa* was, in truth, the only European-introduced pigment plant to arouse any local interest in Polynesia; Kooijman (1972) describes its use in Fiji, Samoa, Futuna, ʻUvea and Hawaiʻi. He also mentions juice of the imported domesticated orange (*Citrus aurantifolia*) being used in the Cooks to provide a pale orange dye; differentiating this from the more orange-hued end of mati's range on the one hand, and from turmeric on the other, is a piece of work remaining for scholars of Cook Islands art to undertake. In reality, perhaps the most notable feature of the Polynesian tapa makers' response to European-imported dyes is a general disinterest: indigo arrived early with European settlers, as did the 'washing blue' that became so important to Melanesian art, but there seems to have been minimal interest in dyeing or painting tapa blue anywhere in Polynesia outside of Hawaiʻi, and American Samoa during the 20th century. Indigo plants could easily have been imported from eastern Melanesia at many points in the preceding centuries, but it seems that there simply was no interest. Equally, synthetic dyes have been available in the region for more than a century, and while they have gained some popularity in matting, basketry, and (of course) dress-making with woven fabrics, it is clear that a conservative aesthetic filter surrounds colour in Polynesian tapa decoration.

Discussion

This has been a relatively brief regional overview of Polynesian pigments outside of Hawaiʻi. We have attempted to provide both a summary of the historical data and useful findings from our experimental reconstructions of dye production on Mangaia. The fabric dyes and

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pigments of Polynesia have been presented here as a set of seven related groups, based on the plant parts exploited and the technology of their extraction: the sap-based pigments of resinous browns and reds; the soot-based black pigments suspended in them; the anaerobic silt blacks; the rhizome and root infusions producing the principal yellows; the brilliant reds based on the mati reaction; a mixed group of simple plant extracts; and a cluster of ochreous oil-based paints that were heavily eroded by annatto in the late 19th century.

Our experimental reconstruction of traditional dye extraction processes on Mangaia has helped to resolve some key uncertainties about the source plant parts, and finer details about the extraction methods and visual traits of certain pigments, allowing us to better differentiate the sap-based pigments and the yellows than before. Equally, a lot of rigorous ethnobotanical work has been undertaken in recent years – certainly since Kooijman wrote *Tapa in Polynesia* in 1972 – and we may clarify the botanical identities of certain historically documented pigment plants. That this new data of secondary synthesis can still be produced so easily shows how much more remains to be rediscovered by contemporary makers in the Pacific, and researchers around the world.

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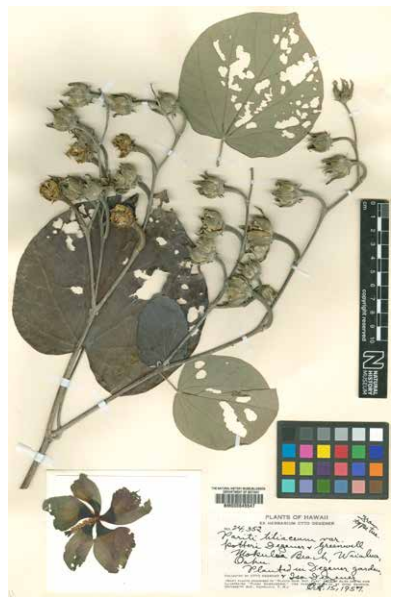
~ Plant Profile 5: Fibre ~

Beach hibiscus, Sea hibiscus *Hibiscus tiliaceus* L. (also known as *Talipariti tiliaceum* (L.) Fryxell) MALVACEAE

Mark Nesbitt



Left: Leaves at Haiku, Maui, Hawai'i.
Right: Otto Degener 24352, Waialua, Oahu, Hawai'i, 1957 (Natural History Museum London, BM000645547).

Beach hibiscus is a medium-sized tree, 3-10 metres in height and forming a tangled thicket. It is native to coastal areas throughout the tropics and on most high islands of Polynesia, though its native status in Hawai'i and other islands in eastern Polynesia is uncertain. It is easily cultivated from seed or cuttings, and has also become naturalised, with potential to be invasive. It is an important source of a soft timber, and is also used as living fencing and in medicine. It remains one of the most important fibre sources in the Pacific. The inner bark can be used without further processing, split into strands to be woven into kava strainers, netting and other basketry. After retting in seawater, the bark takes on a lacy appearance and is used in clothing such as 'grass' skirts. Hibiscus is not a well known tapa species, but some early travellers recorded its use for barkcloth in Niue, the Cook Islands, the Austral Islands and Hawai'i, and fibre analysis has confirmed this in one case (Chapter 1; Tamburini et al., 2019).

Vernacular names (selected): Tonga, Samoa, 'Uvea, Futuna: *fau*; Cook Islands: *'au*; Society Islands: *purau, fau*; Hawai'i: *hau*; Fiji: *vau*.

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~ Plant Profile 6: Fibre ~

ʻĀkia *Wikstroemia uva-ursi* A. Gray THYMELAEACEAE

Mark Nesbitt

Left: Plant at Waimea Arboretum and Botanical Garden , Oahu, Hawaiʻi.
Right: U.S. South Pacific Exploring Expedition under the command of Capt. Wilkes, XI/66 (Kew, K000900252).

ʻĀkia is a wild plant native to four of the Hawaiian islands. It is a sprawling shrub, up to 1.5 metres high, and is relatively uncommon in coastal and dry forest habitats, although now increasingly used for landscaping. The inner bark of several Hawaiian species were used for cordage, and there is a single historic reference to its use in kapa (Fornander, 1919: 636). Lisa Schattenburg-Raymond (Chapter 4) considers it may have been used as a component of double-retted fibre, *pōpō*, in Hawaiʻi. Other species occurring in Hawaiʻi and other Polynesian islands have also have been used for cordage.

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6

Hawaiian Dyes and Kapa Pigments: A Modern Perspective and Brief Analysis of the Historic Record

Lisa Schattenburg-Raymond

The colour palette of *kapa* (Hawaiian tapa) created at the time of Captain Cook's visits in 1778 and 1779, as seen in the pieces collected or observed by both him and his crew, included white, brown, black, yellow, red, and blue. These are the only kapa pieces one can observe that are certainly without Western influence, and they provide a glimpse of the Hawaiian aesthetic before contact. It must be acknowledged that definitive conclusions about the variety of all dye colours achieved by Hawaiians at the time of Cook's visits cannot be made, as neither what was collected, nor what was observed was representative of all the kapa being made in Hawai'i at the time. It is possible that Hawaiians in various geographical areas other than those Cook visited may have had particular styles, patterns, or colours associated with them.

Like other kapa making practitioners, I am fascinated with these early pieces. However, my own interest in dyes began years before I became a kapa maker. My mother was an ethnobotanist and fibre artist; while she was in college at the University of Hawai'i she studied with the renowned ethnobotanist Beatrice Krauss. Using both native and non-native plants, she conducted extensive research into natural dyes, and interesting dye concoctions were often present in our home. Though my mother was unsuccessful, she endeavoured to create the red and blue colours known to have been used in Hawaiian kapa. I have been more fortunate with producing those colours in recent years. As a horticulturalist and former Director of the Maui Nui Botanical Gardens, I had access to many Hawaiian plants with which to experiment. I focused my research specifically on Hawaiian plants and other dye sources that would have been available in the 19th century to create the colours found on early Hawaiian pieces. Over the last 20 years, I have made several exciting discoveries which have allowed me to produce several blues, reds, and even the ever-elusive green; in fact, all the colours of the rainbow (Figures 6.1 and 6.2).

Scholarly research has played an important role in making these discoveries, and as a researcher, I have primarily relied on the works of Samuel Manaiakalani Kamakau, William T. Brigham, Te Rangi Hiroa (Peter Buck) (1957) and Simon Kooijman (1972).

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